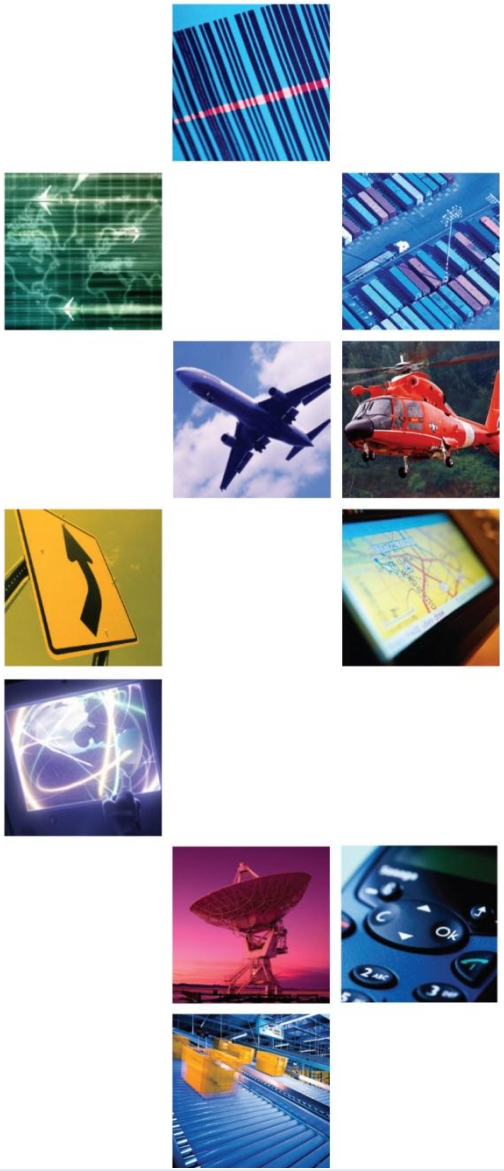


> insight > action > transformation

Technical Conference on USPS Network Simulation Modeling

May 1, 2012

decision/analysis partners, LLC

Outline

- decision/analysis partners LLC background
- Model and study objectives and background
- Model results
  - Scenarios modeled
  - Results
- Network simulation model structure
- Q & A

decision/analysis partners LLC background

- Management and technical advisory services
  - Founded in 1999 - 10 full time + over 25 specialized contractors
  - Postal, mailing & shipping advisory services:
    Canada Post – U.S. Postal Service (OIG) – Integrators and service providers.
  - Logistics/supply chain advisory services:
    Coast Guard – Defense Logistics Agency
  - Telecom advisory services:
    GSA – Trade & Development Agency – Others
- Deep postal roots and expertise
  - Processing –Transportation – Networks – Products - Markets.
  - Consultants – Modeling Specialists – Analysts - Economists – Postal Experts
  - Tools: Labor – Bundling – Plant Flows/Layout/Productivity – Networks – etc.
  - Over 50 postal projects in last 3 years

Model objectives and background

- Model capabilities:
  - Evaluate the impacts on service performance and costs of changes in distribution, processing, transportation or new technology
- Features:
  - Considers both processing and transportation in the simulation of mail movements,
  - Uses detailed distribution rules and information on plant capabilities and productivity,
  - Considers capacity bottlenecks and time in transit to determine service performance against critical times.
- Model initially developed for USPS-OIG in 2010, and significantly enhanced subsequently

Study objectives

- APWU approached d/ap based on the USPS OIG work
- d/ap was asked to analyze the impact of the number of facilities on service performance and costs
  - Provide a notional understanding of the effects of varying numbers of facilities
- d/ap enhanced the initial OIG model
  - Improved model distribution logic significantly
  - Used USPS FY2010 operating conditions, volumes, and published service standards as the baseline
  - Focused on First Class Mail, letters and flats
    - Standard mail, BPM and Periodicals are also included in the model
- d/ap modeled a number of scenarios as requested by APWU

STUDY SCENARIOS & RESULTS

Baseline scenario

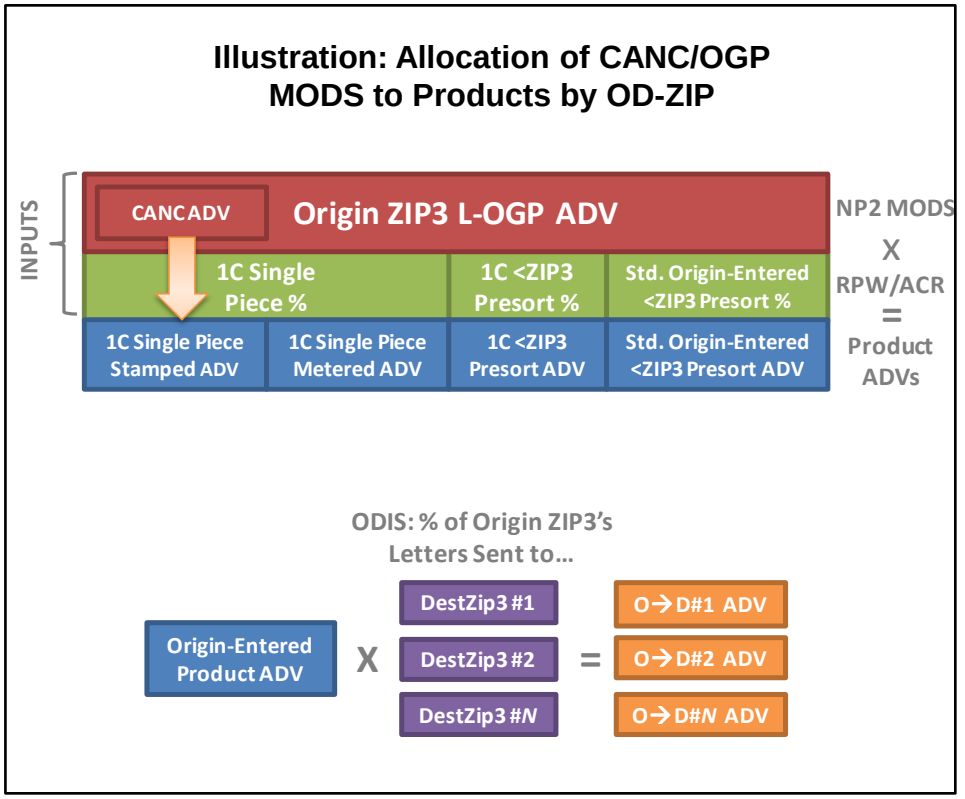
- USPS FY2010 network ‘topology’
  - 477 baseline facilities identified (including 21 NDCs)
  - Processing capacity as reported in N2102-1 LR17
- Distribution Rules
  - USPS FY2010 NP2 MODS Facility Assignments and Labeling Lists (L004, L801, L601)
- Mail Volume and Mail Characteristics
  - O-D pair distribution : FY2010 ODIS NP11
  - Average daily volumes: FY2010 RPW, Mail characteristics study (ACR2010 LR 14)
  - Presort levels and network entry points: Mail characteristics study (ACR2010 LR 14)
  - Lbs/pc, Cu-ft/pc: RPW based on volume weighted averages for constituent products
- Validated against NP2-MODS data by processing facility and processing operation

Baseline facility set

- 477 facilities is used in the baseline network simulation model.
  - Includes 466 facilities defined as all facilities having conducted some combination of letter, flat, or parcel sorting during FY 2010
    - USPS-LR-N2012-1/NP2
    - Includes 4 NDCs of the 21 NDCs.
  - The baseline set is then augmented with 17 NDCs to represent all 21 NDCs as facilities that conduct cross docking operations.
  - The 477-baseline set excludes 6 non-NDCs that NP2 reports as having conducted strictly parcel processing during FY2010.
    - Moreover, these facilities are not on LR15.
  - Excludes 7 facilities located outside the contiguous 48 states

Input average daily volumes

- Goal was ‘topology’-independent allocation of ADVs for Products across O-D ZIPs
  - Product = Class/Shape combination
- Disaggregated NP2 MODS volumes
- Accounted for:
  - Product proportions by presort-levels
  - Product network-induction points
  - ODIS distribution



Validation of baseline model
National-level comparison

National-Level Comparison: Model vs FY10 NP2 MODS Average Daily Volumes								
	CANC	L-OGP	L-INP	L-INS1	L-INS2	F-OGP	F-INP	F-INS
Model Raw ADV Piececount	**73,572,376**	**135,299,112**	**223,660,974**	**364,473,713**	**328,133,980**	**10,038,537**	**26,646,277**	**41,125,673**
NDC OGP Volumes, not in NP2 (-)		(3,383,470)				(34,170)		
Model Adjusted ADV	**73,572,376**	**131,915,642**	**223,660,974**	**364,473,713**	**328,133,980**	**10,004,367**	**26,646,277**	**41,125,673**
NP2 FY10 MODS ADV	**74,434,482**	**132,782,282**	**226,298,001**	**364,229,929**	**327,854,915**	**10,027,938**	**26,861,471**	**41,364,235**
Model vs NP2 MODS Comparison	**99%**	**99%**	**99%**	**100%**	**100%**	**100%**	**99%**	**99%**

Validation of baseline model
Illustration of plant-level comparison

	L-OGP			L-INS1			
Model Facility	**Model**	**NP2MODS**	**% vs.**	**Model**	**NP2MODS**	**% vs.**	**Model 1C**
ST LOUIS MO			100%			96%	
PHOENIX AZ			101%			102%	
KANSAS CITY MO			99%			101%	
LOS ANGELES CA			100%			94%	
DENVER CO			100%			104%	
NORTH METRO GA			100%			97%	

Validation of baseline model
Cost comparisons

COMPARISON OF MODEL AND USPS N2012-1 BASELINE COSTS		
PROCESSING COST CATEGORY	**MODEL COST 456 Facilities (Excluding 21 NDCs)**	**N2012-1 COST (Also Excludes 21 NDCs)**
Variable Mail Processing Labor	$4.158B (Estimated for 456 NP2 Facilities)	$4.547B (453 LR15 Facilities)
Fixed Mail Processing Labor	$1.133B (456 NP2 Facilities)	Not Reported
Overhead (Supplies, Fixed Opening, Fixed Operating, Admin/Other Labor, Maintenance Labor)	$7.236B (**456** NP2 Facilities)	$8.033B (**404** LR14 Facilities for Supplies and Admin/Other, Maintenance Labor Costs; **476** LR15 Facilities for Fixed Opening and Fixed Operating Costs)
TOTAL	**$12.527B**	**$12.580B**

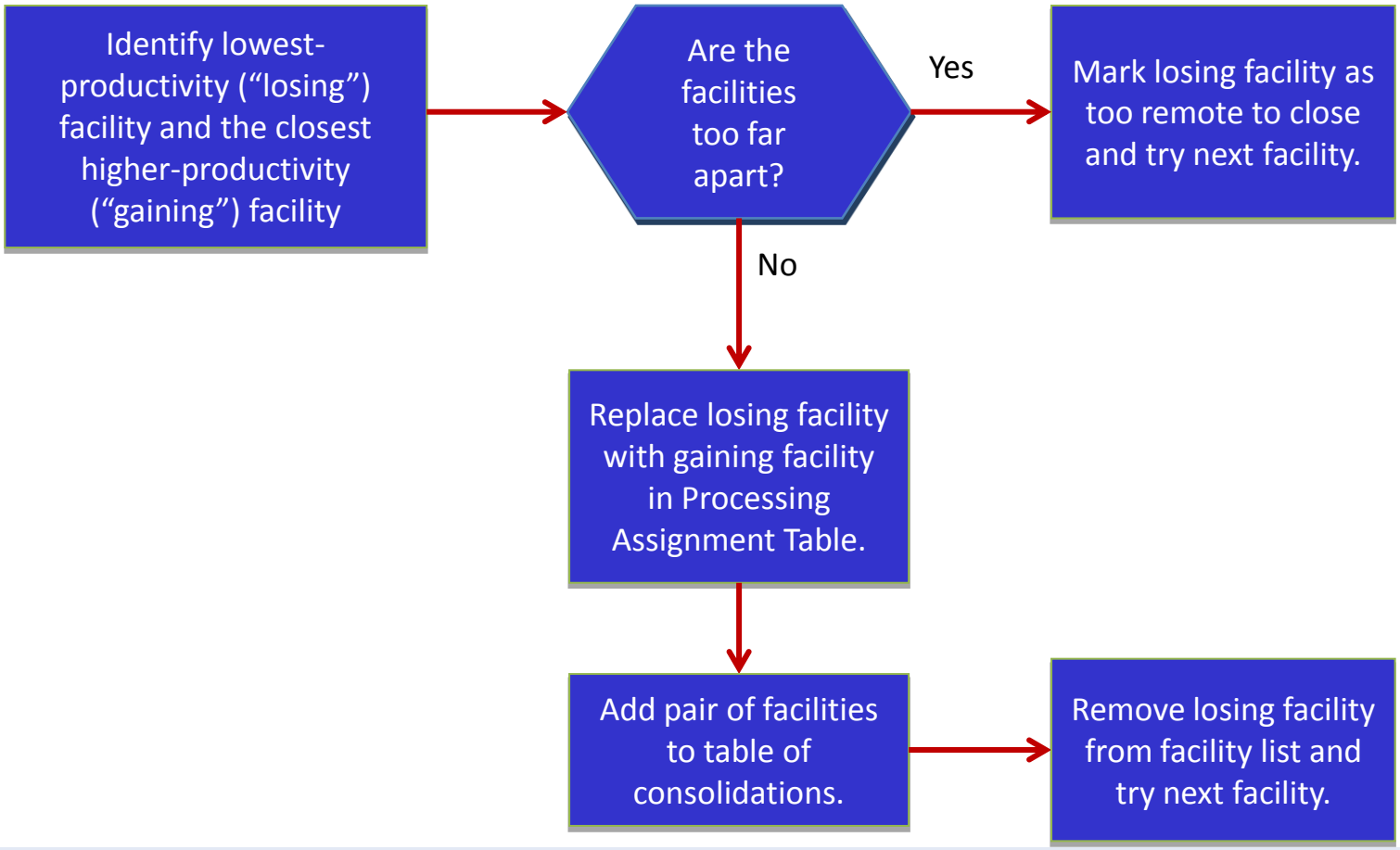
Scenarios modeled

A. Using average daily volumes, analyze the impact of fewer facilities on service performance and costs
   - 7 scenarios with facilities ranging from 411 to 250
   - Reassigning losing facilities to ADC/AADCs primarily

B. Same as A, using peak volumes
   - 12.3% increase based on December-only average monthly MODS letters + flats volume over the corresponding average monthly volume for the entire year (Source LR49).

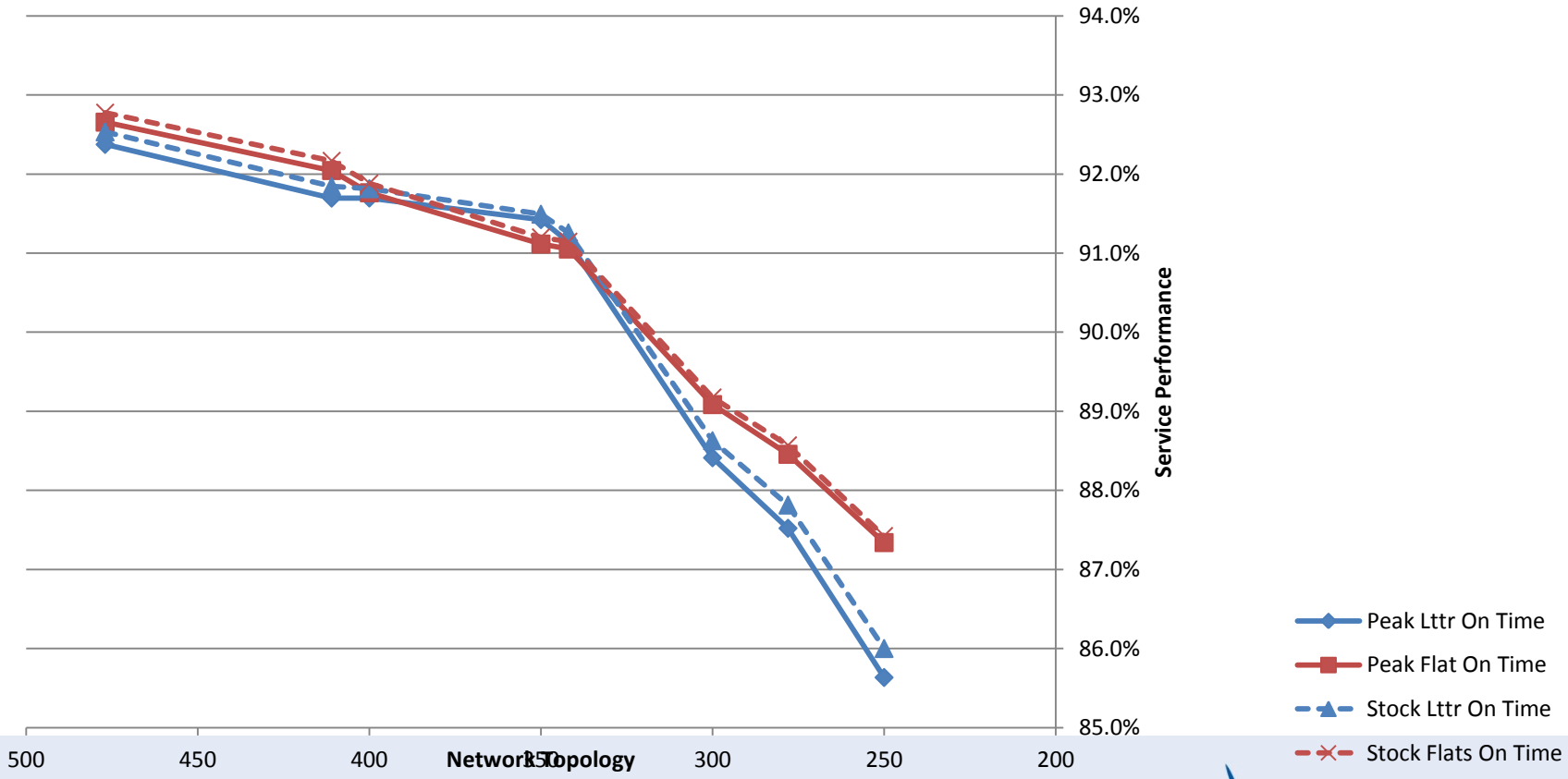
Scenario conditions
   - Idealized conditions using nominal equipment throughputs
   - No allowance for machine failure, variation in equipment throughput, fluctuations in volumes, variations in transit times, transportation capacity limitations.
   - No manual operations modeled

Facility reassignment logic

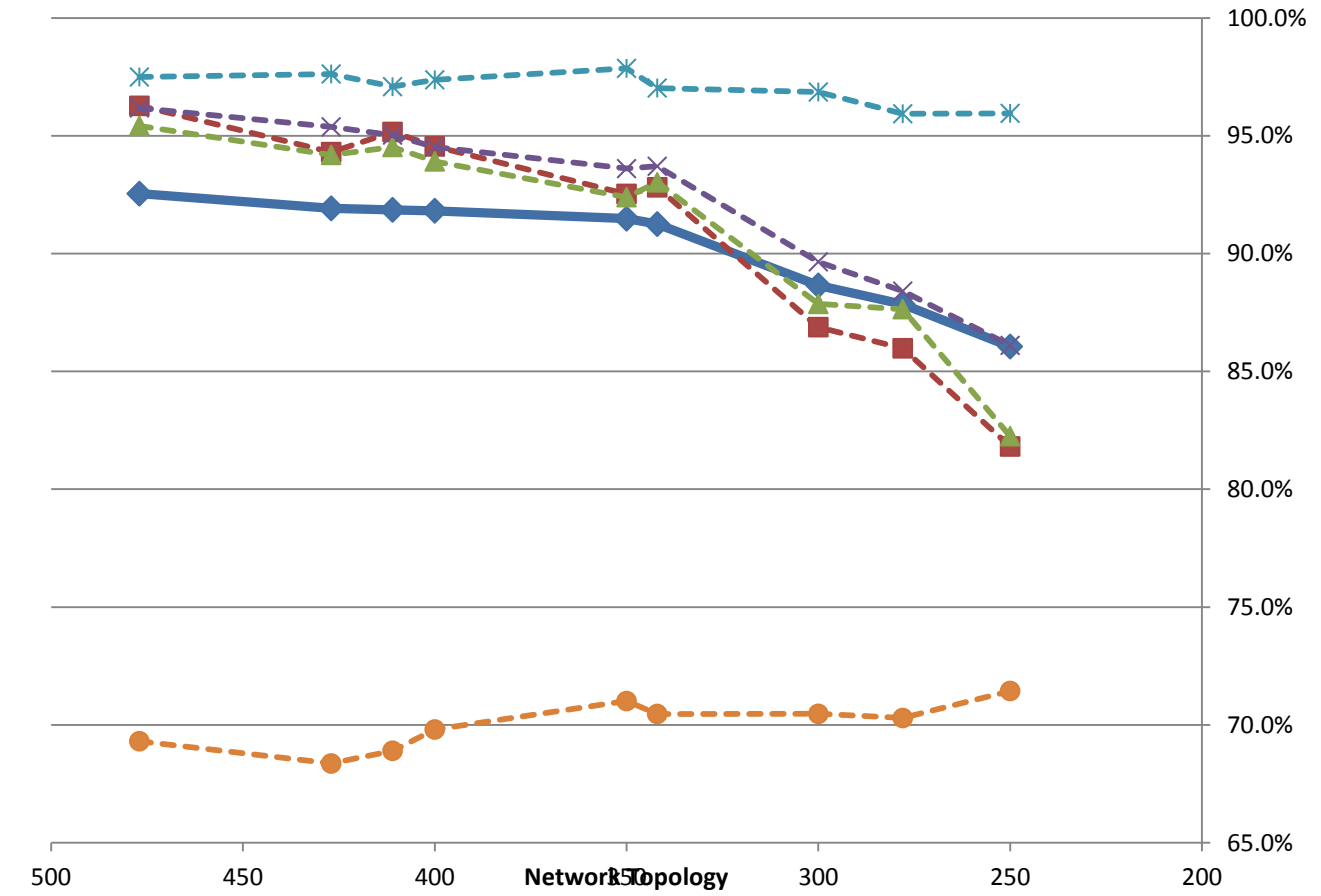


Study Results – Average and Peak Day Volume

Decrease in service performance as the number of network facilities drops
Drop in performance becomes steeper as the number of facilities decreases



Study Results – Presented in our PRC testimony



Intra-SCF clusters

- Overnight Turnaround where Origin ZIP = Destin ZIP
- Overnight Non-Turnaround – where OD pair is in the same SCF, but O-ZIP <> D-ZIP

Inter-SCF clusters

- Overnight
- D+2
- D+3

Overall
Intra-SCF Turnaround
Intra-SCF Non-Turnaround
Inter-SCF Overnight
Inter-SCF D+2
Inter-SCF D+3

Scenario results

Scenario Name	# of Facilities	On-Time Service Performance (%)					
			Overnight Mail				
		Overall	Intra-SCF Turnaround (Origin ZIP = Destin ZIP	Intra-SCF Non-Turnaround (Origin ZIP <> Destin ZIP)	Inter-SCF D+1	Inter-SCF D+2	Inter-SCF D+3
Baseline	477	92.5%	96.2%	95.4%	69.3%	96.2%	97.5%
Top Three Quartiles	411	91.9%	95.1%	94.5%	68.9%	95.1%	97.1%
Shoot For 400	400	91.8%	94.5%	93.9%	69.8%	94.5%	97.4%
Shoot For 350	350	91.5%	92.5%	92.3%	71.0%	93.6%	97.9%
Top Half	342	91.2%	92.8%	93.0%	70.4%	93.7%	97.1%
Shoot For 300	300	88.6%	86.8%	88.0%	70.5%	89.6%	96.8%
Top Quartile	278	87.8%	86.0%	87.7%	70.2%	88.4%	96.0%
ShootFor250	250	86.0%	81.6%	81.9%	71.5%	86.1%	96.0%

Study Results – Operating Costs Presented in our PRC testimony

		Letters & Flats Processing & Overhead Costs (millions of $)								
		Processing Costs					Overhead Costs		Total Costs	
		Fixed Costs		Variable Costs						
Scenario Name	# Facilities	Cost	% of Baseline	Letters Cost	Flats Cost	% of Baseline	Costs	% of Baseline	**Total Costs**	**% of Baseline**
Baseline	477	$1,125	--	$1,650	$717	--	$6,027	--	$9,519	--
TopThreeQuarters	411	$1,114	99.0%	$1,649	$712	99.7%	$5,951	98.8%	$9,428	99.1%
ShootFor400	400	$1,112	98.9%	$1,649	$708	99.6%	$5,936	98.5%	$9,407	98.8%
ShootFor350	350	$1,103	98.1%	$1,649	$697	99.1%	$5,815	96.5%	$9,266	97.3%
TopHalf	342	$1,102	98.0%	$1,648	$700	99.2%	$5,845	97.0%	$9,297	97.7%
ShootFor300	300	$1,095	97.3%	$1,635	$686	98.1%	$5,532	91.8%	$8,950	94.0%
TopQuarter	278	$1,091	97.0%	$1,633	$688	98.0%	$5,478	90.9%	$8,892	93.4%
ShootFor250	250	$1,062	94.4%	$1,615	$667	96.4%	$5,116	84.9%	$8,462	88.9%

Study Results – Operating Costs Peak Day Volume

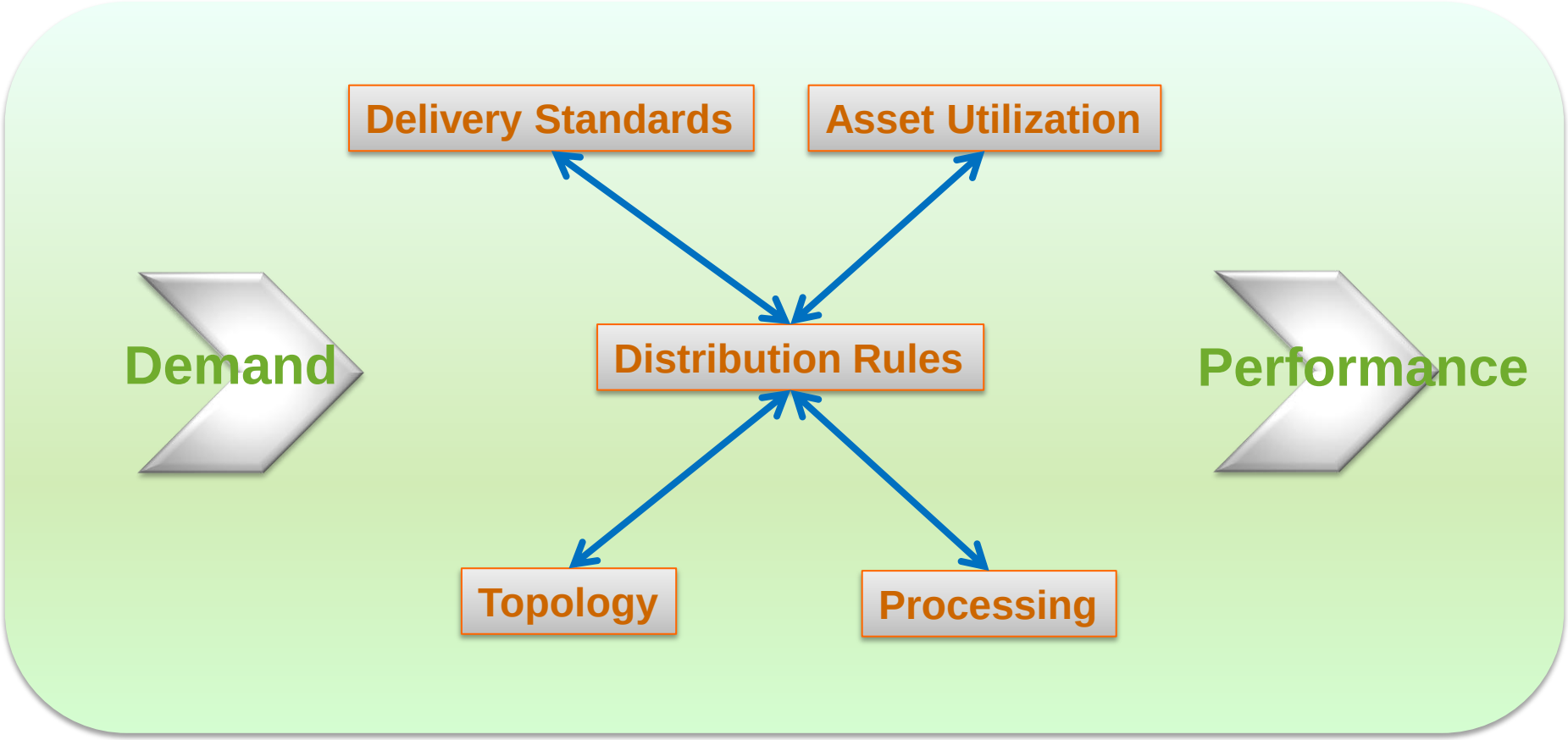
		Letters & Flats Processing & Overhead Costs (millions of $)								
		Processing Costs					Overhead Costs		Total Costs	
		Fixed Costs		Variable Costs						
Scenario Name	# Facilities	Cost	% of Baseline	Letters Cost	Flats Cost	% of Baseline	Costs	% of Baseline	**Total Costs**	**% of Baseline**
Baseline	477	$1,125	--	$1,852	$801	--	$6,027	--	$9,805	--
PostAMP	427	$1,116	99.2%	$1,848	$790	99.4%	$5,865	97.3%	$9,620	98.1%
TopThreeQuarters	411	$1,114	99.0%	$1,850	$796	99.7%	$5,951	98.8%	$9,711	99.1%
ShootFor400	400	$1,112	98.9%	$1,850	$791	99.6%	$5,936	98.5%	$9,689	98.8%
ShootFor350	350	$1,103	98.1%	$1,850	$779	99.1%	$5,815	96.5%	$9,548	97.4%
TopHalf	342	$1,102	98.0%	$1,850	$782	99.2%	$5,845	97.0%	$9,579	97.7%
ShootFor300	300	$1,095	97.3%	$1,834	$767	98.1%	$5,532	91.8%	$9,228	94.1%
TopQuarter	278	$1,091	97.0%	$1,829	$769	97.9%	$5,478	90.9%	$9,168	93.5%
ShootFor250	250	$1,062	94.4%	$1,806	$746	96.2%	$5,116	84.9%	$8,729	89.0%

NETWORK SIMULATION MODEL STRUCTURE

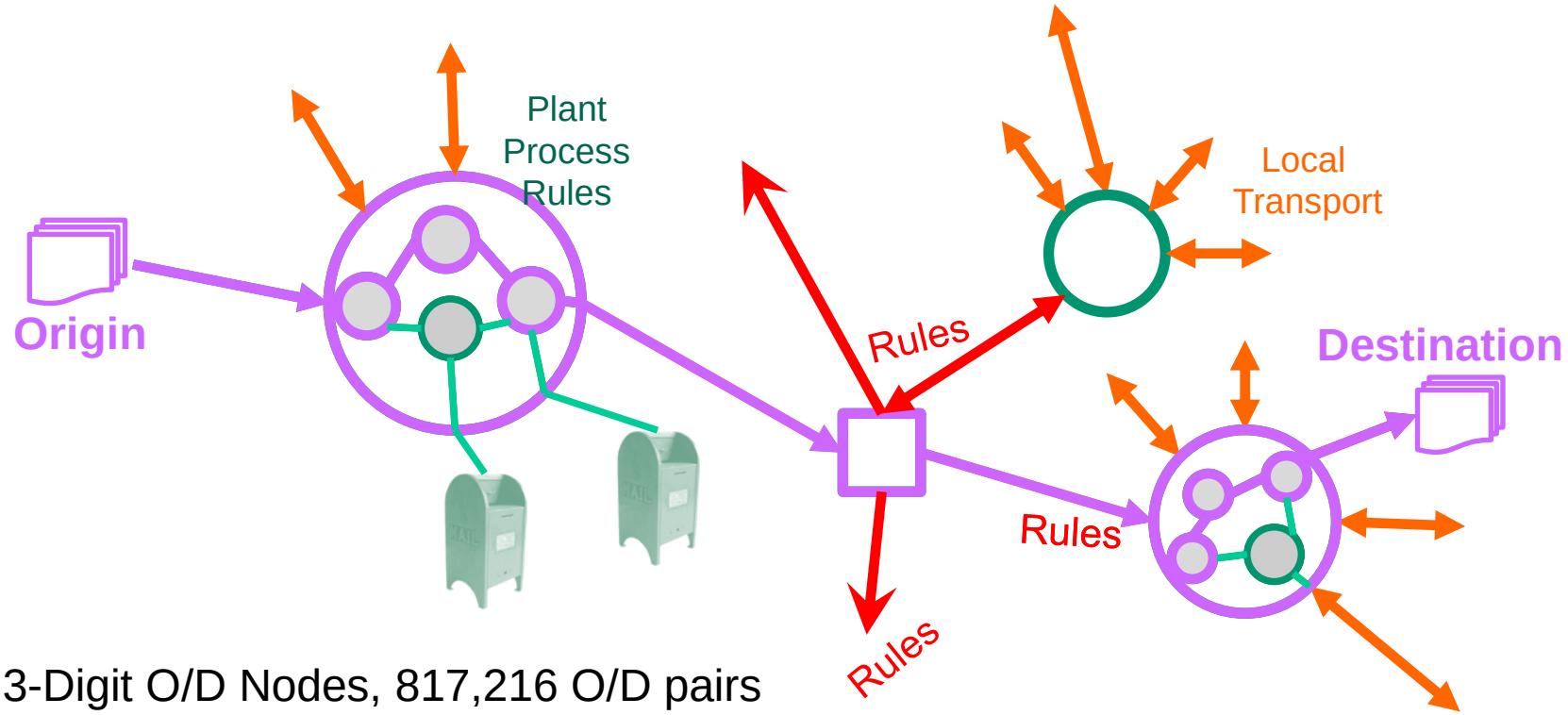
Network Simulation Model Structure

1. Overall model structure
2. Distribution rules organized by ZIP3
3. ‘Mail Unit’: Fundamental data structure
4. Modeled USPS products
5. Presort levels and entry points
6. Mail flows and sort levels
7. Mail processing sort levels
8. Simulation process
9. Statistics collected
10. Service performance determination
11. Cost and productivity calculations
12. Technology

1. Model Structure



1. Model structure



- 904 3-Digit O/D Nodes, 817,216 O/D pairs
- ~10 Million Mail Units representing ~780 million mail items
- 2,664 Transportation Links (Surface & Air)

2. Distribution rules organized by ZIP3

- The **ZIP3** represents an organizing structure for the model
  - Mail volumes are captured by Origin-Destination ZIP3 (OD pair)
  - Processing facilities are assigned to ZIP3s.
  - Each ZIP3 is assigned the following facilities:
    - Outgoing processing facility – for letters and flats; First Class and Standard
    - Outgoing processing facility – for parcels; all classes
    - Incoming processing facility – for letters and flats; First Class and Standard
    - Area distribution centers (AADCs) – for letters; First Class
    - Area distribution centers (ADCs) – for flats and periodicals; First Class
    - Area distribution centers (ADCs) – for flats and bound printed matter; Standard
- This organizing structure **allows ZIP3s to be reassigned to any open facility** in the network, while volumes traded within an OD pair remain unaffected

ZIP3	CANC/L-F-OUTG Facility	L-F-INC Facility	AADC Facility	ADC-FCM Facility	ADC-STD Facility	NDC Facility

3. ‘Mail Unit’: Fundamental data structure

- A ‘mail unit’ represents a logical grouping of mail items. It has the following attributes:
  1. The **Product** category consisting of the **Shape** (letter, flat) and **Class** (FCM, Standard) of the mail item.
  2. The **Sort Level**
     - It consists of the depth to which a Mail Unit is sorted at any point through the flow . Sort levels are:
       - No sort
       - ZIP3 sort
       - ZIP 5 sort
       - Carrier Route sort
       - DPS sort
  3. The origin and destination ZIP3
  4. The induction date
  5. The piece count included in the mail unit
- The **Service Standard** of the mail unit is derived from its class and ZIP3 OD pair

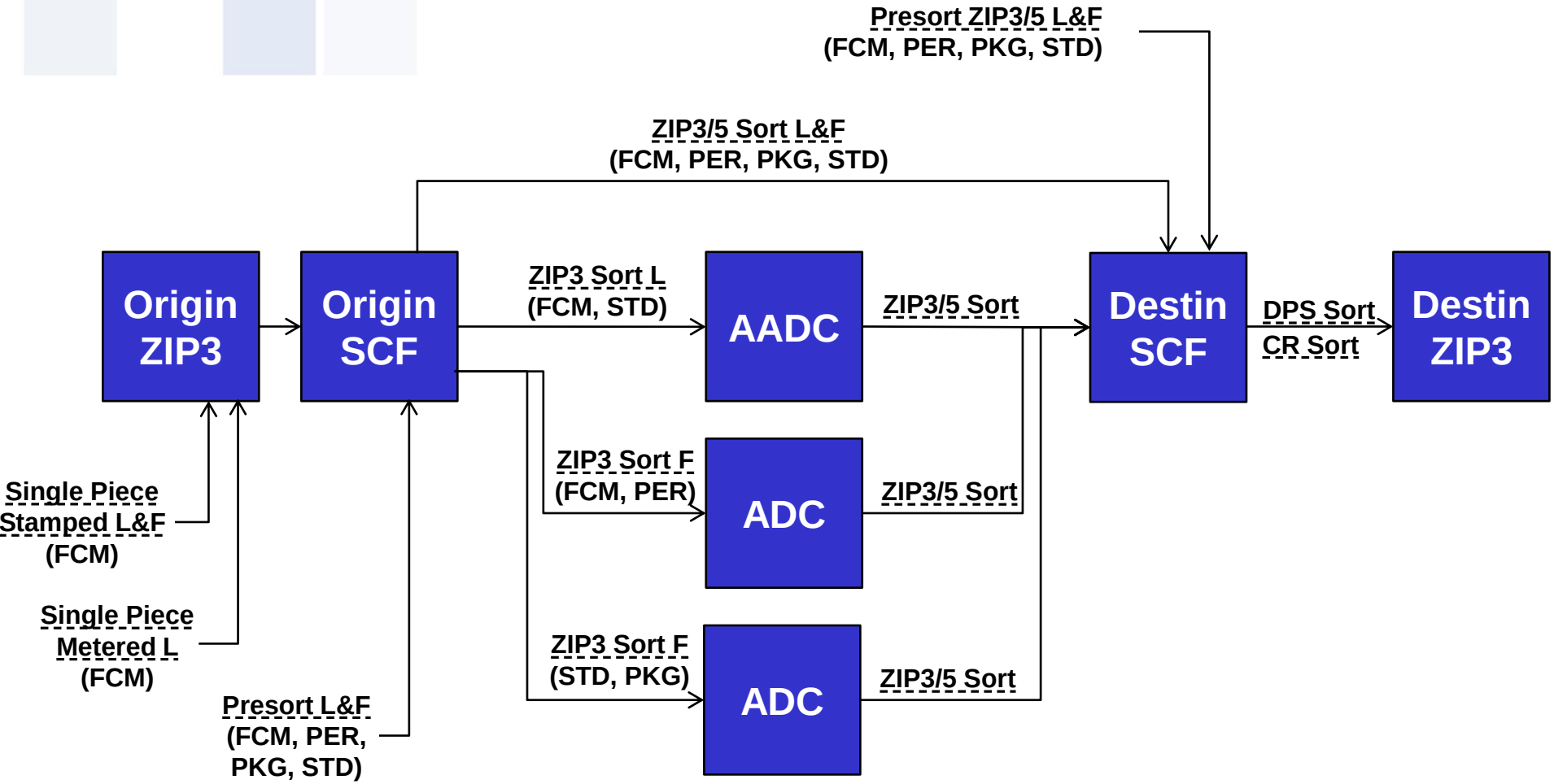
4. Modeled USPS products

Shape	Class	Presorted	USPS Constituent Mail Categories
Letters	First Class	N	1C Single Piece Letters/Cards
		Y	1C Non-carrier Route Letters/Cards
	Standard	Y	Standard Letters, Non-ECR
Flats	First Class	N	1C Single Piece Flats
		Y	1C Non-carrier Route Flats
	Standard	Y	Standard Flats, Non-ECR
	Periodicals	Y	In/Outside County Periodicals
	Package	Y	Package Service BPM Flats

5. Presort levels and entry points

			DSCF-Entered		DNDC-Entered			Origin-Entered		
Shape	Class	Pre-sorted	ZIP5 Presort	ZIP3 Presort	ZIP5 Presort	ZIP3 Presort	<ZIP3 Presort	ZIP5 Presort	ZIP3 Presort	<ZIP3 Presort
Letters	FCM	N								100%
		Y						48.24%	35.37%	16.39%
	Std	Y	38.5%	13.85%	8.07%	14.11%	2.19%	4.87%	8.41%	10.0%
Flats	FCM	N								100%
		Y						25.13%	43.26%	31.60%
	Std	Y	38.21%	5.35%	18.93%	8.86%	0.15%	10.33%	13.70%	4.48%
	Period.	Y	2.84%	1.75%				63.37%	24.83%	7.21%
	Package	Y		59.76%		18.31%			19.24%	2.69%

6. Mail flows and sort levels

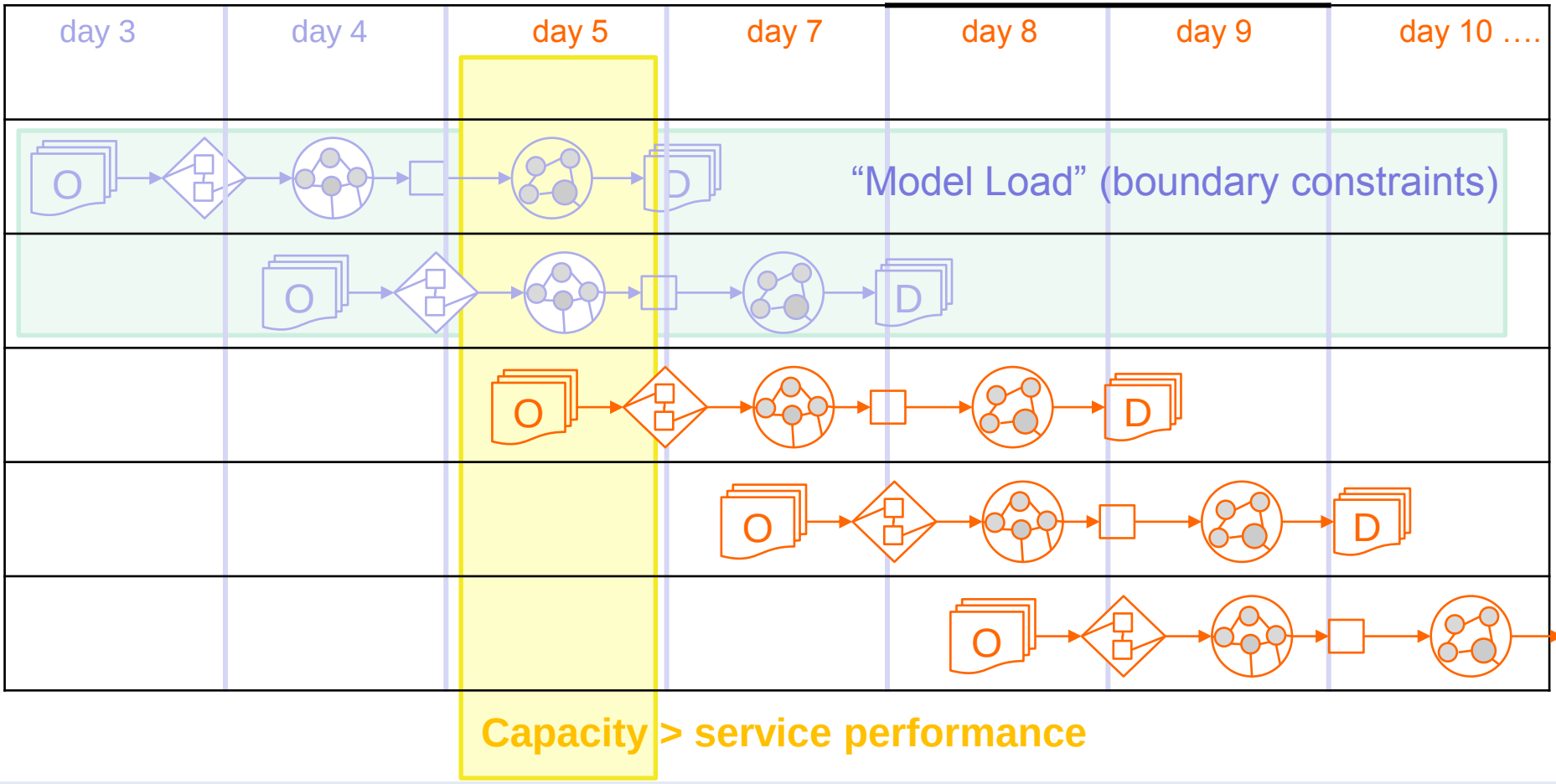


L = Letters; F = Flats

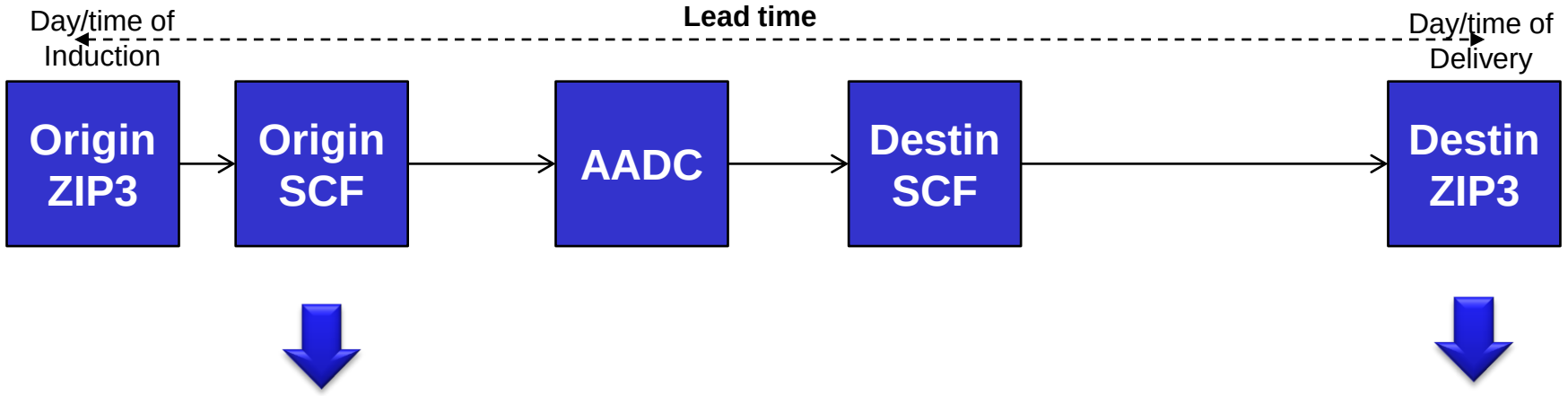
7. Mail processing sort levels

	RESULTING SORT LEVEL TRANSITIONS	
OPERATION	**Letters**	**Flats**
Cancellation	None	N/A
Outgoing Primary	None→ZIP3	None→ZIP3
Managed Mail	ZIP3 → ZIP3 ZIP3 → ZIP5	ZIP3 → ZIP 3 ZIP3 → ZIP5
Incoming Primary	ZIP3→ZIP5	ZIP3→ZIP5
Incoming Secondary	ZIP5→DPS	ZIP5→Carrier Route

8. Simulation process



9. Statistics collected



Time in Transit Constraints
% mail entering past critical entry time for Canceling operation

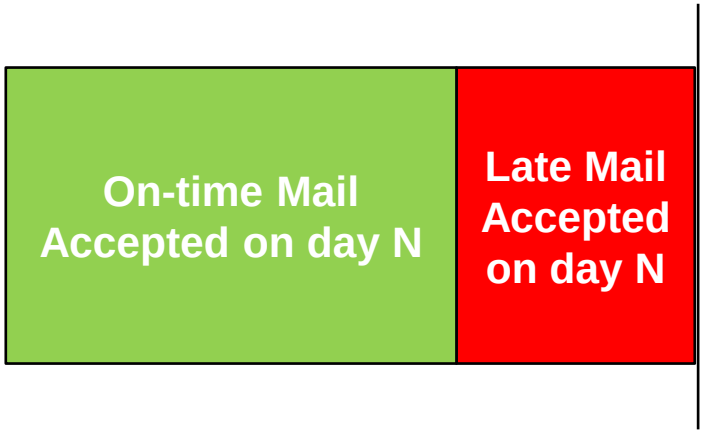
Proxy for effect of time in transit from O-ZIP3 to O-SCF on service

Machine Utilization
Volume of FCM worked as a % of available processing capacity

Service Performance
% FCM on time,

1. Turnaround OD pairs
2. Overnight Intra SCF OD pairs
3. Overnight Inter-SCF OD pairs
4. D+2 Inter-SCF OD pairs
5. D+3 Inter-SCF OD pairs

10. Service performance determination



$$Ontime\ Service\ Performance = \frac{Volume\ accepted\ Day\ N - Volume\ accepted\ Day\ N\ but\ late}{Volume\ accepted\ Day\ N}$$

11. Productivity and cost calculations

- Productivity = $\frac{\text{Total Processing Demand Workload (in sq-ft equivalents)}}{\text{Total Cost}}$

- Processing Demand Workload:
  - Sum of LTTR, FLAT, PRCL Demand Units (expressed in sq-ft equivalents).

- Total Cost Equals Sum Of:
  - Total variable RT processing cost = Variable RT unit demand cost[1] x total demand workload[2]
  - Total fixed RT cost = Fixed RT unit cost[3] x Facility square feet[1]
  - Overhead cost = Unit Overhead cost[4] x Facility square feet[1]

1) Source : LR15
2) Source : NP2
3) Source : LR46
4) Sources: LR 14 Overhead Regression Worksheet for Supplies, Admin/Other Labor, Maintenance Labor; LR 15 for Fixed Opening and Fixed Operating Costs

12. Technology

- MASON Toolkit (**M**ulti-**A**gent **S**imulator **O**f **N**eighborhoods...or **N**etworks... or something...)
  - 100% Java-based
  - Platform-independent; consistent results across platforms
  - Fast discrete-event multi-agent simulation library core
  - Designed for large custom-purpose Java simulations

- d/ap postal, mailing & shipping overlay
  - decision/analysis postal, mailing & shipping model overlay
  - **Processing rules** move mail within processing centers, modifying its sort state with each incremental operation. Performance measured against critical entry time, clearance time
  - **Distribution rules** flow mail between facilities (processing centers and/or transportation hubs)

BACKUP SLIDES

Shape	Class	Lbs Per Piece	Cubic Feet Per Piece	Pre-sorted	USPS Constituent Mail Categories	Avg Daily Non-CR, Non-DDU Volume
Letters	First Class	0.03922	0.00225	N	1C Single Piece Letters/Cards	94,734,962
				Y	1C Non-carrier Route Letters/Cards	153,064,193
	Standard	0.05991	0.00276	Y	Standard Letters, Non-ECR	159,887,665
Flats	First Class	0.20961	0.00922	N	1C Single Piece Flats	6,237,122
	Standard	0.25160	0.00773	Y	1C Non-carrier Route Flats	2,220,237
				Y	Standard Flats, Non-ECR	23,321,959
	Periodicals	0.38520	0.01390	Y	In/Outside County Periodicals	9,170,597
	Package	1.37230	0.05850	Y	Package Services BPM Flats	454,400

Scenario results

Scenario Name	# of Facilities	On-Time Service Performance (%)					
			Overnight Mail				
		Overall	Intra-SCF Turnaround (Origin ZIP = Destin ZIP	Intra-SCF Non-Turnaround (Origin ZIP <> Destin ZIP)	Inter-SCF D+1	Inter-SCF D+2	Inter-SCF D+3
Baseline	477	92.5%	96.2%	95.4%	69.3%	96.2%	97.5%
Top Three Quartiles	411	91.9%	95.1%	94.5%	68.9%	95.1%	97.1%
Shoot For 400	400	91.8%	94.5%	93.9%	69.8%	94.5%	97.4%
Shoot For 350	350	91.5%	92.5%	92.3%	71.0%	93.6%	97.9%
Top Half	342	91.2%	92.8%	93.0%	70.4%	93.7%	97.1%
Shoot For 300	300	88.6%	86.8%	88.0%	70.5%	89.6%	96.8%
Top Quartile	278	87.8%	86.0%	87.7%	70.2%	88.4%	96.0%
ShootFor250	250	86.0%	81.6%	81.9%	71.5%	86.1%	96.0%

Operating Windows

ALL SHAPES		
Start Time	End Time	Event or Time Window
06:30	N/A	Incoming dispatch time from incoming facility to destination ZIP3.
00:30	N/A	Outgoing dispatch time to downstream ADC/AADC or facility.
LETTERS - FCM		
Start Time	End Time	Event or Time Window
16:00	N/A	30% of origin-entered mail inducted
18:00	N/A	70% of origin-entered mail inducted
16:00	23:00	Cancellation processing window
16:00	00:00	Outgoing processing window
14:00	02:00	Incoming primary processing window
23:00	02:30	DPS 1-st pass processing window
02:30	06:30	DPS 2nd pass processing window

Operating Windows

LETTERS - STD		
Start Time	End Time	Event or Time Window
08:00	16:00	Destination drop-ship time window
08:00	20:00	Incoming primary processing window
23:00	02:30	DPS 1-st pass processing window
02:30	06:30	DPS 2nd pass processing window
FLATS - FCM AND PERIODICALS		
Start Time	End Time	Event or Time Window
16:00	N/A	30% of origin-entered mail inducted
18:00	N/A	70% of origin-entered mail inducted
16:00	00:00	Outgoing processing window
14:00	02:00	Incoming primary processing window
00:00	06:30	INS (Carrier Route sort) processing window

Operating Windows

FLATS - STD/PACKAGE		
08:00	16:00	Destination drop-ship time window
07:00	18:00	Incoming primary processing window
08:00	00:00	INS (Carrier Route sort) processing window